Figure S1. Biomass samples from different regions of China.

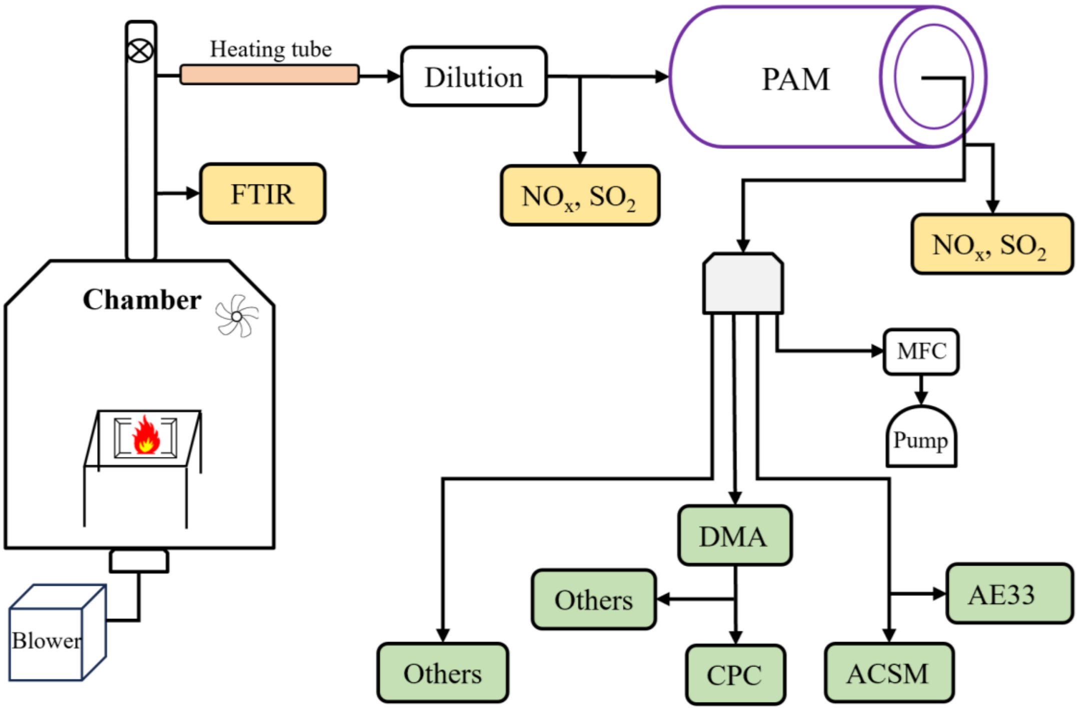

Figure S2. Schematic diagram of the experimental configuration.

Table S1. Statistics of related parameters of different biomass combustion.

Biomass type	Sources	Aged day	# of tests	RH (%)	MCE	CO/CO_2
Wheat straw (WS)	Xi'an	0, 2	8	18.5	0.96	0.044
		0, 7	7	9.5	0.96	0.049
Rice straw (RS)	Shichuan	0, 2	10	18.4	0.97	0.030
		0, 7	8	15.8	0.97	0.029
Corn straw (CS)	Jiangsu	0, 2	7	13.3	0.97	0.034
		0, 7	7	11.8	0.99	0.015
Soybean straw (SS)	Liaoning	0, 2	9	16.9	0.95	0.048
		0, 7	7	18.9	0.98	0.037
Apple branch (AB)	Hubei	0, 2	8	15.4	0.98	0.021
		0, 7	6	16.6	0.97	0.034

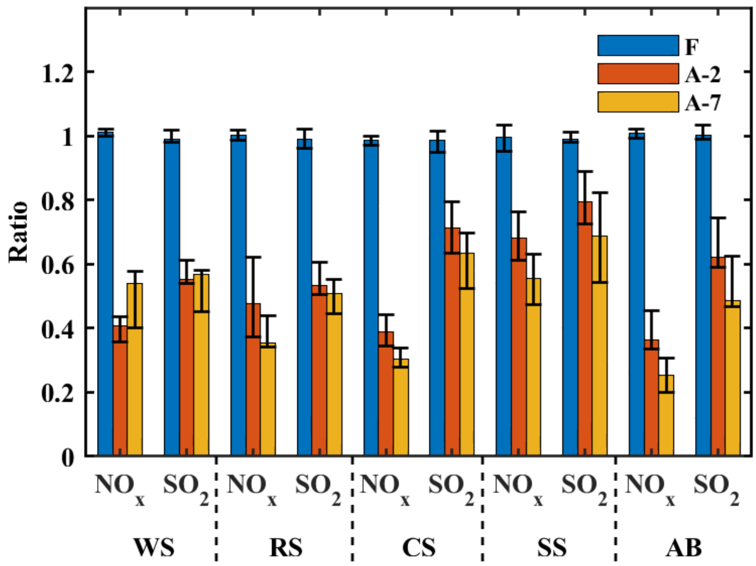

Figure S3. The ratio of NO_x and SO_2 measured after PAM to those before PAM for smoke emitted from different biomass combustion at different aging levels.

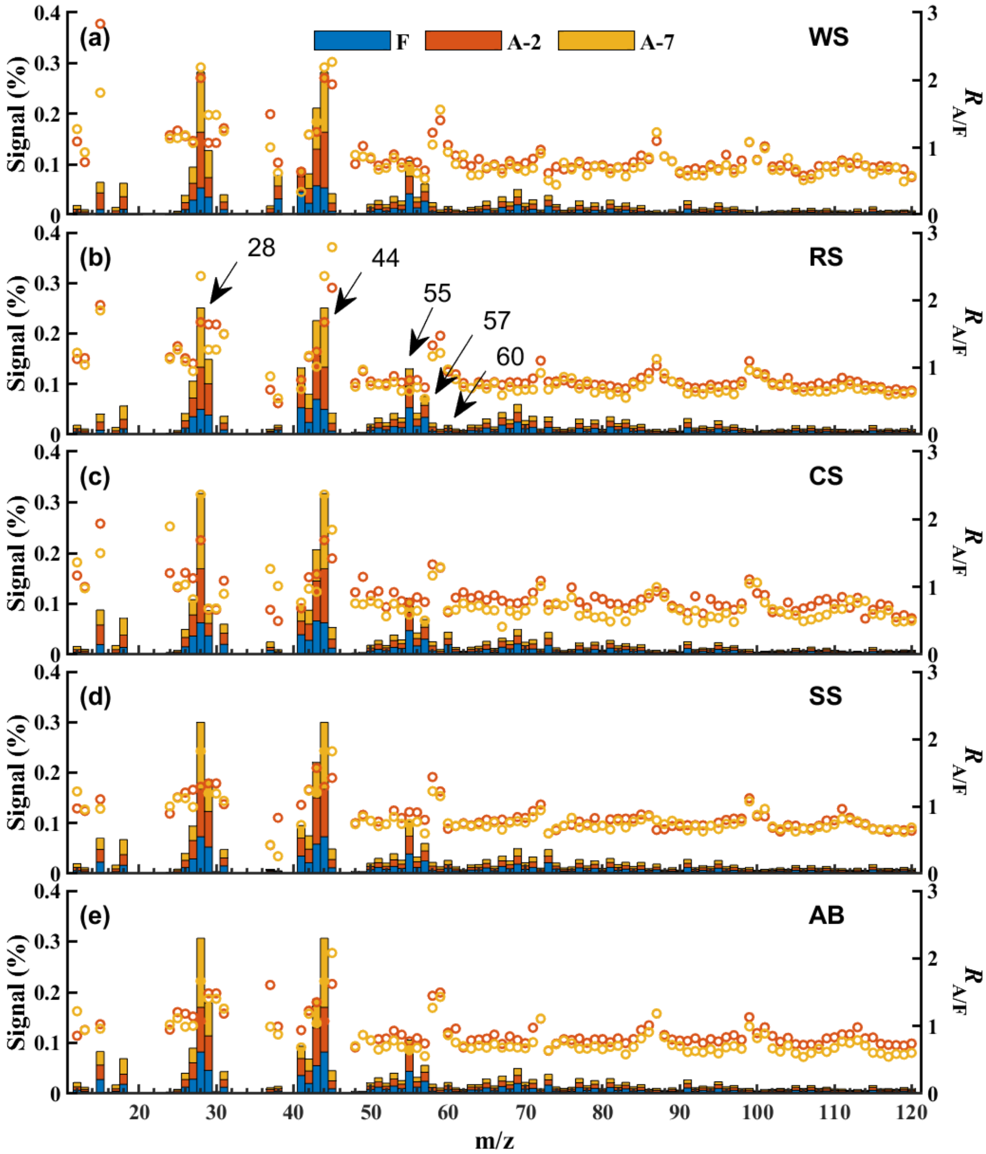

Figure S4. The stack diagram of high-resolution mass spectra for aerosols emitted by different biomass combustion at different aging levels. The scatter represents the ratio of the mass spectrum of A-2 and A-7 to F ($R_{A/F}$), respectively.

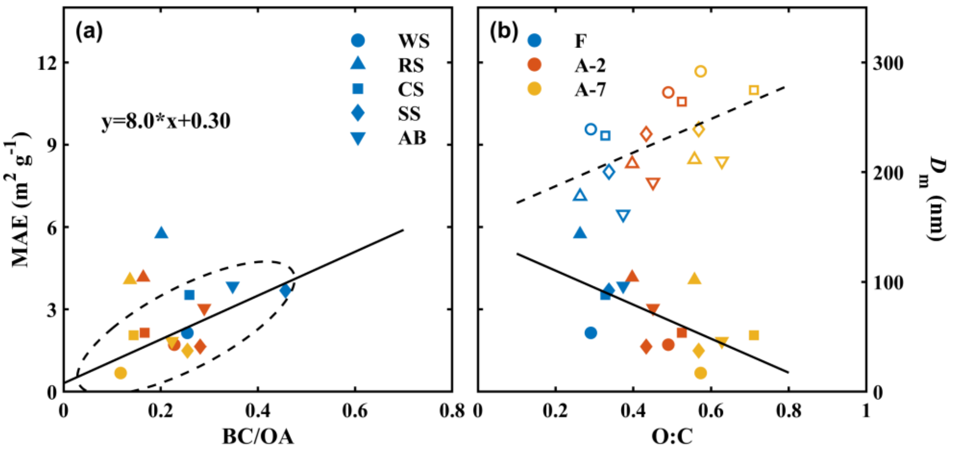

Figure S5. (a) The MAE as a function of BC/OA for different species and aging levels. (b) The solid points and lines corresponding to the left Y-axis represent the relationship between MAE and O:C, and the hollow points and dashed lines corresponding to the right Y-axis represent the relationship between D_m and O:C.

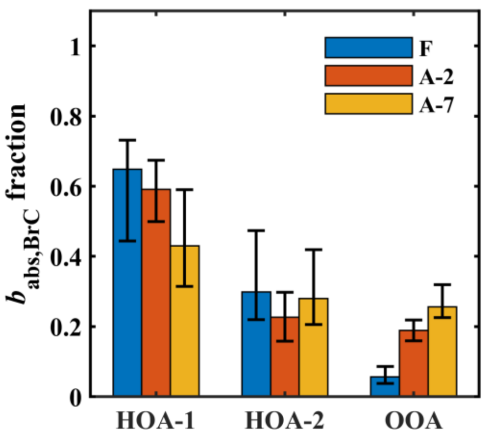

Figure S6. Relative contribution of BrC light absorption at 370 nm from different OA factors.

Table S2. The *ER* of different chemical components of biomass smoke at different aging levels.

Biomass type	**Species**	**A-2**	**A-7**
WS	Org.	1.4	1.8
	SO_4^{2-}	2.3	3.1
	NO_3^-	2.9	2.0
	NH_4^+	0.87	0.97
	Cl^-	0.70	0.77
RS	Org.	1.3	1.5
	SO_4^{2-}	1.8	2.7
	NO_3^-	2.4	2.6
	NH_4^+	1.0	1.2
	Cl^-	0.93	0.95
CS	Org.	1.3	1.4
	SO_4^{2-}	1.8	2.7
	NO_3^-	2.1	2.2
	NH_4^+	0.58	0.75
	Cl^-	0.69	0.66
SS	Org.	1.6	1.9
	SO_4^{2-}	1.1	1.7
	NO_3^-	1.7	2.2
	NH_4^+	1.5	1.7
	Cl^-	0.92	1.0
AB	Org.	1.4	1.6
	SO_4^{2-}	1.4	2.0
	NO_3^-	1.5	1.6
	NH_4^+	1.5	2.0
	Cl^-	0.91	0.97

Table S3. Summary of correlations between different OA factors and major tracer ions.

r^2	**HOA-1**	**HOA-2**	**OOA**
NO_3^-	0.09	0.09	**0.51**
SO_4^{2-}	0.01	0.19	**0.58**
BC	0.06	**0.50**	0.07
m/z 43 ($C_2H_3O^+$)	0.22	0.01	**0.72**
m/z 44 (CO_2^+)	0.01	0.03	**0.90**
m/z 55 ($C_4H_7^+$)	**0.85**	0.20	0.07
m/z 57 ($C_4H_9^+$)	**0.90**	0.25	0.01
m/z 60 ($C_2H_4O_2^+$)	0.25	**0.41**	0.23
m/z 73 ($C_3H_5O_2^+$)	0.13	**0.68**	0.15

Table S4. Light absorption properties associated with brown carbon from biomass burning in laboratory in China compared with other countries.

Locations	Fuel types		Proxy	λ (nm)	MAE (m^2/g)	References
Europe	Wood (laboratory, chamber)		POA	370	5.5	(Kumar et al., 2018)
			SOA		2.4	
America	(laboratory, chamber)	Mixing	POA	405	0.4-2.5	(Cappa et al., 2020)
			SOA		0.2	
America	(laboratory, chamber)	Pine	OA	405	1.4	(Siemens et al., 2024)
		Sage			2.2	
		Grass			2.5	
America	(Outdoor, chamber)	Hickory	POC	280	3.5	(Zhong and Jang, 2014)
			SOC		2.5	
Bangladesh	(laboratory, stove)	Mixing	OC	370	12.7	(Pavel et al., 2023)
China	Crop residue (field, stove)	Corn	OC	370	4.3-5.6	(Zhang et al., 2021a)
	Wood (field, stove)	Wood branches	OC	370	5.2	
		Wood logs			5.1	
	Crop residue (field, stove)	Rape	OC	370	6.3	(Zhang et al., 2020a)
		Corn			5.2-5.9	
	Wood	Wood branches	OC		5.1	
		Bamboo			4.4	
		Wood logs			3.4	
	Crop residue (laboratory, chamber)	Rice	OA	370	2.6	(Fang et al., 2022)
		Corn			2.2	
		Sorghum			3.5	
	Crop residue (laboratory, chamber)	Wheat	OA	370	3.0	(Chen et al., 2024)
		Rice			4.5	
		Corn			4.7	
	Wood	Elm			3.4	
	Crop residue (laboratory, chamber)	Corn	OC	365	1.9	(Zhang et al., 2023)

Table S5. Atmospheric light absorption properties associated with brown carbon from different sources observed in China compared with other countries.

Locations		Types	Seasons	Proxy	λ (nm)	MAE (m^2/g)	References
France	Paris	Urban	Winter	HOA	370	1.1	(Zhang et al., 2020c)
				LO-BBOA		4.9	
				MO-BBOA		2.0	
				OOA		0.6	
Greece	Athens	Urban	Winter	HOA	370	1.3	(Kaskaoutis et al., 2021)
				COA		6.5	
				BBOA		7.6	
				SV-OOA		4.0	
				LV-OOA		2.0	
	Athens	Urban	Annual	OA	370	3.8	(Liakakou et al., 2020)
Mexico	Mexico	Urban	Winter	HOA	532	2.4	(Prieto et al., 2023)
				LV-OOA		5.7	
				SV-OOA		1.0	
Amazonia	Rio Branco	Urban	Autumn	All	370	4.9	(Ponczek et al., 2022)
				HOA		2.1	
				BBOA		9.3	
				OOA		0.8-0.9	
Slovenia	Loški Potok	Rural	Winter	OA	370	2.4	(Cuesta-Mosquera et al., 2024)
India	Bhopal	Urban	Annual	OC	405	2.2	(Bhardwaj et al., 2023)
	Singapore	Urban	Spring	HOA		0.5-1.7	(Kasthuriarachchi et al., 2020)
				COA		0.06-0.1	
				LO-OOA		0.7-1.3	
	Delhi	Urban	Winter	HOA	370	0.4	(Singh et al., 2021)
				BBOA		0.9	
				SV-OOA		0.7	
China	PRD	Urban	Summer	OC	405	0.7	(Li et al., 2018)
			Autumn	OC		1.3	
	Hongkong	Urban	Winter	OC	365	1.2	(Zhang et al., 2020b)
	Lulang	Remote	Annual	OC	405	0.7	(Zhao et al., 2019)
	Chongqing	Urban	Winter	OC	405	0.8	(Peng et al., 2020b)
			Summer	OC		0.3	
	Xian	Urban	Winter	OC	365	2.0	(Zhang et al., 2020b)
	Beijing	Suburb	Spring	OC	370	2.2	(Yang et al., 2009)
	Chongqing	Urban	Winter	OC	405	0.7	(Peng et al., 2020a)
	Chengdu	Urban	Winter	OC		0.7	(Peng et al., 2020a)
	Beijing	Urban	Winter	OC	370	1.5	(Wu et al., 2021)
	Guangzhou	Urban	Autumn	OC	405	1.0	(Zhang et al., 2021b)

TP	High-altitude	Annual	BBOA		2.3	(Zhang et al., 2021c)
			MO-OOA	370	0.6	
			NOA		2.2	
Taiwan	High-altitude	Autumn	OC	550	0.8	(Pani et al., 2022)
		Spring	OC		0.8	
Guangzhou	Suburban	Autumn	HOA	370	0.6	(Qin et al., 2018)
			BBOA		3.4	
			LV-OOA		1.0	
Xianghe	Suburban	Winter	HOA	370	0.5	(Wang et al., 2019)
			BBOA		3.4	
			CCOA		5.7	
Lijiang	Suburban	Spring	BBOA	370	2.8	(Tian et al., 2023)
			CCOA		1.4	
Eastern of TP	-	Winter	OC	405	2.8	(Zhao et al., 2022)
Xian	Urban	Winter	POA	370	0.3	(Tian et al., 2022)
			LV-OOA		0.3	
Hainan Island	Urban	Spring	OC	370	0.9	(Wang et al., 2020)
Beijing	Urban	Autumn	BBOA	370	0.1-8.1	(Sun et al., 2023)
			FOA		5.1-5.2	
Shanghai	Urban	Annual	OC	405	0.6	(Zhou et al., 2022)
Mount Hua	High-altitude	Summer	POC	370	0.4	(Gao et al., 2022)
			SOC	370	2.1	
Suzhou	Urban	Annual	POC	370	11.7	(Xu et al., 2024)
			SOC		3.3	
Baoji	Urban	Summer	POC	370	1.3-1.4	(Li et al., 2024)
			SOC		3.6-4.1	
Nanchang	Urban	Autumn	OC	405	1.5	(Zou et al., 2023)

The main proxies in the table are: hydrocarbon-like OA (HOA), coal combustion OA (CCOA), cooking-like OA (COA), biomass burning OA (BBOA), semi-volatile oxygenated OA (SV-OOA), low-volatility oxygenated OA (LV-OOA), less (LO-OOA) or more (MO-OOA) oxidized OA, primary organic carbon (POC) and secondary organic carbon (SOC).

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